07/26/05

AF$ 1764

Attorney's Docket No. MSN-32778

PATENT

IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

Appellant	:	Stefan Miersch
Serial No.	:	10/008,603
Filing Date	:	November 9, 2001
For	:	Method and Apparatus for Producing Methane Gas
Group Art Unit:		1764
Examiner	:	Thanh P. Duong
Confirmation No.:		9226

CERTIFICATION UNDER 37 CFR 1.8(a) and 1.10

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Date: July 25, 2005   Jill L. Hauck

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TRANSMITTAL OF APPEAL BRIEF (PATENT APPLICATION-37 C.F.R. 41.37)

1. Transmitted herewith, is the APPEAL BRIEF in this application, with respect to the Notice of Appeal filed on April 27, 2005.

2. STATUS OF APPLICANT

   This application is on behalf of a small entity.

3. FEE FOR FILING APPEAL BRIEF

   Pursuant to 37 C.F.R. 41.20(b)(2), the fee for filing the Appeal Brief is:

   a small entity $250.00

   Appeal Brief fee due **$ 250.00**

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MKE/1056434.1

4. EXTENSION OF TERM

The proceedings herein are for a patent application and the provisions of 37 C.F.R. section 1.136 apply.

Applicant believes that a one month extension of term is required.

5. TOTAL FEE DUE

The total fee due is:

Appeal brief fee	\$ 250.00
Extension fee (if any)	\$ 60.00
TOTAL FEE DUE	**\$ 310.00**

6. FEE PAYMENT

Attached is a check in the sum of \$ 310.00.

7. FEE DEFICIENCY

If any additional extension and/or fee is required, this is a request therefor and to charge Account No. 232053. If any additional fee for claims is required, charge Account No. 232053.

Date: July 25, 2005

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Alan E. Wagner

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Docket No. MSN-32778

BEFORE THE BOARD OF PATENT APPEALS AND INTERFERENCES IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

Appellant (s)	:	Stefan Miersch
Serial No.	:	10/008,603
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Date: July 25, 2005

Jere L. Houk

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Alexandria, VA 22313-1450

Dear Sirs:

APPEAL BRIEF UNDER 37 C.F.R. §41.37

This is an appeal from the final rejection of Claims 7-12 as stated in the Office Action mailed January 11, 2005. The Notice of Appeal was timely filed on April 27, 2005.

I. REAL PARTY IN INTEREST

The real party in interest is Miller-St. Nazianz, Inc.

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II. RELATED APPEALS AND INTERFERENCES

There are no related applications currently either under appeal or the subject of an interference proceeding.

III. STATUS OF CLAIMS

All the claims of this application and their individual status are reported in Appendix 1 to this Appeal Brief. Claims 7-12 are on appeal.

IV. STATUS OF AMENDMENTS

All amendments have been entered.

V. SUMMARY OF INVENTION

VI. ISSUES

The issue on appeal is whether or not the following final rejections are in error:

Claims 7-8 and 11-12 were finally rejected under 35 U.S.C. § 103(a) as being unpatentable over Garvin et al. (US 5,461,843) in view of Bremmer (US 4,579,654) and Chow (US 4,157,958).

Claim 9 was finally rejected under 35 U.S.C. § 103(a) as being unpatentable over Garvin et al. in view of Bremmer and Chow and further in view of Courtland (US 3,981,803).

Claim 10 was finally rejected under 35 U.S.C.§ 103(a) as being unpatentable over Garvin et al. in view of Bremmer and Chow in view of Courtland and further in view of Pogoda (US 4,267,147).

Claims 8-12 depend from independent Claim 7 and are therefore allowable over the prior art if Claim 7 is so allowable. Furthermore, all of the claims stand or fall together in this appeal. Therefore, although the Examiner provided separate support and/or rejections for the elements in each claim, only the rejection of Claim 7 is relevant.

VII. GROUPING OF CLAIMS

In the arguments below, all claims stand together.

VIII. ARGUMENT

The Applicant believes that the Examiner's rejections are in error both from technology and legal grounds. First, the Examiner has misunderstood both the teachings of the primary reference and the fundamental science underlying the methane gas generation. Second, the proposed modification of the primary reference would completely alter the principle of operation of the primary reference and render the invention of that reference unsuitable for its original purpose. Third, the proposed modification would not work as either the original invention or as the invention currently under appeal. Fourth, if the proposed modification did work as the current invention, the result would potentially be a highly explosive mixture. Therefore, the Applicant requests that the Examiner's rejections be overturned.

ERROR 1: The rejection of Claims 7-12 under 35 U.S.C. §103(a) is in error because the proposed *prima facie* case is insufficient and also legally barred.

The Appellants believe that the Examiner has failed to meet the standards for an obviousness rejection and, therefore, has not established a *prima facie* case of obviousness.

A. Requirements for a *Prima facie* Case of Obviousness

The Examiner's fundamental error in rejecting the claims on appeal is that he has failed to establish a *prima facie* case of obviousness.

> In rejecting claims under 35 U.S.C. §103, the examiner bears the initial burden of presenting a *prima facie* case of obviousness . . . 'A *prima facie* case of obviousness is established when the teachings from the prior art itself would appear to have suggested the claimed subject matter to a person of ordinary skill in the art . . .'" *In re Rijckaert*, 9 F.3d 1531, 1532, 28 U.S.P.Q.2d 1955, 1956 (Fed. Cir. 1993).

Specifically, to establish *prima facie* obviousness of a claimed invention, all the claim limitations must be taught or suggested by the prior art. See *In re Royka*, 180 USPQ 580 (CCPA 1974). In addition, in order to establish a *prima facie* case of obviousness, the Examiner must show some objective teaching in the prior art or that knowledge generally available to one of ordinary skill in the art would lead that individual to combine the relevant teachings of the references. *See*, *e.g.*, *In re Fine*, 5 USPQ2d 1596, 1598 (Fed. Cir. 1988). Furthermore, in leading one skilled in the art, the prior art must suggest to the ordinary skilled artisan that the combination should be carried out and would have a reasonable likelihood of success, viewed in the light of the prior art. *In re Dow Chemical Co*, 5 USPQ2d 1529, 1532 (Fed. Cir. 1988)(emphasis added). Indeed, both the suggestion and the expectation of success must be found in the prior art, not in the Appellant's disclosure. Id. Additionally, the Federal Circuit has stated that a reference should be considered in its entirety, with due consideration given to disclosures that diverge or teach away from the invention as well as disclosures which direct one skilled in the art to the invention. *Ashland Oil, Inc. v. Delta Resins & Refractories, Inc.*, 227 U.S.P.Q. 657, 669 (Fed. Cir. 1985).

Furthermore, certain combinations or types of modifications of the prior art are legally barred to prevent the USPTO from applying improper hindsight to the obviousness determination. Relevant here, if proposed modification would render the prior art invention being modified unsatisfactory for its intended purpose, then there is no suggestion or motivation to make the proposed modification. *In re Gordon*, 733 F.2d 900, 221 USPQ 1125 (Fed. Cir. 1984). Equally relevant, if the proposed modification or combination of the prior art would change the principle of operation of the prior art invention being modified, then the teachings of the references are not sufficient to render the claims *prima facie* obvious. *In re Ratti*, 270 F.2d 810, 123 USPQ 349 (CCPA 1959).

B. Final Rejection

Claim 7 (and Claims 8 and 11-12) was finally rejected under 35 U.S.C. § 103(a) as being unpatentable over Garvin et al. (US 5,461,843) in view of Bremmer (US 4,579,654) and Chow (US 4,157,958). The Examiner states that "Garvin discloses a system for generating methane gas ... from compost," the system comprising: a flexible bag having an open end; the bag having a horizontally extended tube length, the majority of which is "filled with a substantially non-flowable biomass material (compost) in a composition known to produce methane gas (gas generated from compose) (sic)." Internal citations omitted. The Examiner further states that Garvin teaches that the remaining tubular length of the bag is unfilled with the material and that "the bag is tied off and filled with said gas emitted by biomass material (compost)." The Examiner admits certain limitations of the claims are not found in Garvin but he cites the secondary references for the missing disclosures.

C. Reasons the Rejection is in Error

The Applicant believes that all of these rejections are improper because the Examiner has misread Garvin and because the proposed modifications of the primary reference, Garvin et al., are legally barred. In particular, the Applicant believes that the proposed modifications change the principle of operation of Garvin et al. and also, the modified invention of Garvin et al. would be unsuitable for the purpose of the invention of Garvin et al.

The misreadings and technological inaccuracies of the Examiner's rejections are numerous. First, Garvin does not disclose a "system for generating methane gas," but, rather, never even mentions methane anywhere in the patent document. Second, the biomass material in Garvin is not "in a composition known to produce methane gas" as the Examiner asserts. The compost composition of Garvin is highly oxygenated (the system in Garvin provides a constant supply of oxygen to aid the decomposition or drying of the biomass). In contrast, methane generation from compost is an anaerobic process that must occur in the absence of oxygen (see

Exhibit 2, Methane Generation From Livestock, R.W. Hansen). Clearly, an oxygenated composition cannot be a "composition known to produce methane gas." Moreover, the Applicant cannot find any reference in Garvin to tying off the bag and letting the unfilled space fill with gas emitted by the biomass material. Rather, as described more fully below, the bag in Garvin is vented and air is forced from a conduit through the material and out of the vent. These technical and understanding errors are at the heart of the improper rejections.

Second, as stated in the Abstract, Garvin et al. disclosed:

> "A method and apparatus for treating bagged materials" A... conduit... through the open end of the bag and into the bag... is perforated and when the bag is filled, the length of the conduit is extended out through the bag end to be connected to a treatment media, e.g., forced air. An opening is provided at the rear end to provide an exhaust opening for air that is forced into the conduit, out the perforations and through the bagged material. The air will dry the material to lower the moisture content or provide oxygen as may be desired to enhance decomposition."

Therefore, based on the abstract and FIG. 1, in at least one embodiment, the principle of operation for the invention of Garvin et al. is forcing air through a perforated conduit that extends through a bag of bagged materials such that the forced air from the perforated conduit flows through the bagged materials prior to escaping through an open vent. As stated in the specification the forced air is "vented to the atmosphere as indicated by arrows 36." See col. 4, lines 20-26. The purpose of this embodiment of Garvin et al. is to either dry the bagged material or provide oxygen to facilitate decomposition of the bagged material. See the abstract.

As such, the proposed combination of references will impermissibly alter the principle of operation of Garvin et al. Instead of forcing air through the perforated conduit and then through the bagged material and then exhausting through a vent to the atmosphere, the modifications would require that the vent 34 be eliminated so that the methane gas emitted by the biomass

would be able to remain within the bag to be collected through the perforated conduit. Also, instead forcing air through the conduit and into the biomass material, the modified combination would require that methane gas from the bag flow through the conduit to a collection site. If the proposed modification or combination of the prior art would change the principle of operation of the prior art invention being modified, then the teachings of the references are not sufficient to render the claims *prima facie* obvious. *In re Ratti*, 270 F.2d 810, 123 USPQ 349 (CCPA 1959).

Next, the proposed combination of references would render the modified disclosure of Garvin et al. unsuitable for the purpose of Garvin et al. Specifically, air would no longer be forced through the biomass and into the atmosphere to remove gases emitted from the biomass (water vapor and/or decomposition products). Note also, the presence of oxygen hinders the production and collection of methane due at least in part to the rapid and spontaneous reaction of methane with oxygen and also to the anaerobic process for producing methane. Therefore, excluding oxygen by not forcing air through the biomass would not be satisfactory for the purpose of providing oxygen to enhance desired decomposition. If proposed modification would render the prior art invention being modified unsatisfactory for its intended purpose, then there is no suggestion or motivation to make the proposed modification. *In re Gordon*, 733 F.2d 900, 221 USPQ 1125 (Fed. Cir. 1984).

Third, as mentioned above, methane is generated by an anaerobic process. Modifying the aerobic process of Garvin, as proposed by the Examiner, will still result in an aerobic process. Such an aerobic process will not function to produce methane.

Fourth, even if the proposed modifications would produce methane, the user would be left with an air-methane mixture. Such air-methane mixtures are known to be potentially highly explosive at methane concentrations of 6 to 15 percent (see Exhibit 2). One skilled in the art of

composting would not be motivated to modify a prior art invention to make potential bombs out of their users farms.

For the above reasons, the Applicant believes that the Examiner's *prima facie* cases of rejection, all of which are based on Garvin et al., fail.

IX. REQUEST

For the reasons stated in the above argument, Appellants believe that the claims on appeal comply with 35 U.S.C. §103(a), and they request that the final rejection of the claims on appeal be reversed.

Respectfully submitted,

Alan E. Wagner
Registration No.: 45,188

Date: July 25, 2005

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EXHIBIT 1

The claims on appeal are:

WHAT IS CLAIMED IS:

1. (Previously amended) A method for producing methane gas which comprises:

providing a biomass material that will yield methane gas;

adding or not adding inoculants as desired and inserting the biomass material into a large flexible plastic bag having a horizontally extended tubular length to provide a first portion of the bag filled with the biomass material and sealing off both ends of the bag to provide a second bag portion at one end that is unfilled with the material;

said material emitting methane gas that is directed to the second bag portion;' connecting a tube into the bag at the unfilled bag portion with an end of the tube protruded from the bag; and

directing methane gas from the bag and through the tube to a point of collection or use.

2. (Original) A method as defined in Claim 1 including placing a perforated conduit inside the bag along the top of the filled portion of the bag and extended to the unfilled portion of the bag and thereby facilitating flow of the gas to the unfilled portion.

3. (Original) A method as defined in Claim 1 including placing aeration tubes in the biomass material in the filled portion of the bag and extending an end thereof to the bag exterior and compost treating the material following substantial extraction of the methane gas from the material.

4. (Original) A method as defined in Claim 1 including filling multiple bags with the biomass material in accordance with Claim 1 and further including a gas line interconnected with the multiple tubes of said multiple bags and conveying methane gas through the gas line to a collection site.

5. (Original) A method as defined in Claim 1 including placing the bag on a heating pad while being filled and upon being filled, directing hot water to the heating pad to heat the filled bag as desired and to enhance the reaction of the methane gas production.

6. (Original) A method as defined in Claim 1 which includes placing an insulating robe over the bag, inserting water lines between the robe and bag and flowing hot water through the lines to achieve a desired temperature of the material in the bag.

7. (Previously amended) A system for generating methane gas which comprises:

a flexible bag having an open end for mounting to a bag filling machine for filling and compacting the bag with non flowable material, said bag having a horizontally extended tubular length, a majority of said length filled with substantially non-flowable biomass material in a composition known to produce methane gas and as desired adding an inoculant to the material that induce a reaction with the biomass material to include methane gas emission from the biomass [[material.]] material;

a remaining tubular length of the bag as removed from said machine being unfilled with the [[material]] material, said open end tied off and to be filled with said gas emitted by the biomass material, a pipe inserted through the bag wall where filled with said gas for releasing methane gas from the remaining tubular length and a continuation of said pipe directing said gas to a gas collection site.

8. (Original) A system as defined in Claim 7 wherein a conduit is positioned inside the bag at the top of the material in the filled tubular length and extended to the unfilled tubular length for transmitting as to the unfilled tubular length.

9. (Original) A system as defined in Claim 8 wherein a heating bag underlies the bag, water passages are provided in the pad and connected to a hot water source for flowing hot water through the pad and heating thereby the material in the bag.

10. (Original) A system as defined in Claim 9 wherein a robe is placed over the bag, water lines are positioned between the bag and robe and hot water is circulated through the lines for heating the material in the bag.

11. (Original) A system as defined in Claim7 wherein multiple of the defined bags are placed in adjacent relationship and a gas line is connected to the pipes and extended to a collection site for transmitting gas from the bag to the collection site.

12. (Original) A system as defined in Claim 7 wherein the dominant portion of the biomass material is animal waste.

EXHIBIT 2

Colorado State University Cooperative Extension
Putting Knowledge to Work
CSU Cooperdtive Extension - Agriculture

no. 5.002

Methane Generation From Livestock Wastes

by R.W. Hansen [1]

Quick Facts...

- Anaerobic fermentation or digestion is the most promising process for converting organic materials to methane and other gases.
- A simple apparatus can be constructed to produce bio-gas.
- Bio-gas usually contains about 60 to 70 percent methane, 30 to 40 percent carbon dioxide, and other gases.
- The heat value of raw bio-gas is approximately half that of natural gas under typical Colorado conditions.
- Take precautions when processing and handling the gas. It is highly explosive and difficult to detect.

Energy conservation, coupled with concern for the management of livestock wastes, has revived an interest in generating methane from livestock manures.

Converting organic materials, such as animal wastes, to an easily used form of energy can be accomplished by several methods. The process with the greatest potential is anaerobic fermentation or digestion.

The extraction of energy from wastes using anaerobic digestion to produce bio-gas is not new and the general technology is well known. Bio-gas, which is methane and other gases, has been known as swamp gas, sewer gas and fuel gas. Sewage treatment plants generate bio-gas from the sewage sludge as part of the sewage treatment processes. Many small units were used in Europe and India after World War II.

Characteristics of Bio-Gas

Bio-gas usually contains about 60 to 70 percent methane, 30 to 40 percent carbon dioxide, and other gases, including ammonia, hydrogen sulfide, mercaptans and other noxious gases. It also is saturated with water vapor.

The heat value of the raw gas at typical Colorado atmospheric pressures is about 400 to 600 British thermal units (Btu) per cubic foot. In comparison, natural gas has a heat value of 850 Btu per cubic foot and gasoline contains approximately 120,000 Btu per gallon. Partial removal of the impurities may be required. This is not necessarily difficult, but it does complicate the system.

Basic Digester Process

Methane is produced by bacteria. The bacteria are anaerobes and operate only in anaerobic environments (no free oxygen). Constant temperature, pH and fresh organic matter promote maximum methane production. Temperatures usually are maintained at

approximately 95 degrees F. Other temperatures can be used if held constant. For each 20 degrees F decrease, gas production will be cut approximately one half or will take twice as long. A constant temperature is critical. Temperature variations of as little as 5 degrees F can inhibit the methane-formers enough to cause acid accumulation and possible digester failure.

Anaerobic digestion is a two-part process and each part is performed by a specific group of organisms. The first part is the breakdown of complex organic matter (manure) into simple organic compounds by acid-forming bacteria. The second group of microorganisms, the methane-formers, break down the acids into methane and carbon dioxide. In a properly functioning digester, the two groups of bacteria must balance so that the methane-formers use just the acids produced by the acid-formers.

A simple apparatus can produce bio-gas. The amount of the gas and the reliability desired have a great influence on the cost and complexity of the system. A simple batch-loaded digester requires an oxygen-free container, relatively constant temperature, a means of collecting gas, and some mixing. Because methane gas is explosive, appropriate safety precautions are needed.

Tank size is controlled by the number, size and type of animals served, dilution water added, and detention time. The factor that can be most easily changed with regard to tank size is detention time. Ten days is the minimum, but a longer period can be used. The longer the detention time, the larger the tank must be. Longer detention times allow more complete decomposition of the wastes. Fifteen days is a frequently used detention time. Table 1 shows some recommended sizes, dilution ratios and loading rates for different types of animals.

Little volume reduction occurs in an anaerobic digester. Waste fed into the digester will be more than 90 to 95 percent water. The only part that can be reduced is a portion of the solids (about 50 to 60 percent).

The processed material will have less odor. Because it still contains most of the original nitrogen, phosphorus and potassium, and is still highly polluted, the waste cannot enter a stream after it leaves the digester. Lagoons are commonly used to hold the waste until it can be disposed of by either hauling or pumping onto agricultural land.

Table 1: Loading rate guidelines for heated, mixed anaerobic digesters at 95 degrees F being fed fresh livestock manures.*

Factor	**Swine (growing-finishing)**	**Dairy**	**Beef under 700 lbs**	**Poultry layer**	**Poultry broiler**
Dilution ratio manure (manure to water)	1:2.9	Undiluted	1:2.5	1:8.3	1:10.2
Estimated dilution water (gal water/1,000 lbs body wgt)**	15	0	11	47	79
Hydraulic detention time (days)	12.5	17.5	12.5	10	10
Loading rate (lbs volatile solids/cubic foot/day)**	0.14	0.37	0.37	0.13	0.1
Digester volume (cubic feet/1,000 lbs animal wgt) **	30	24	14	72	120

*(From R.J. Smith, The Anaerobic Digestion of Livestock Wastes and the Prospects for Methane Production, Midwest Livestock Waste Management Conference, ISU, Ames, Iowa, Nov. 27-29, 1973)

**To convert to metrics use the following equivalents: 1 gal = 3.8 l; 1 lb = .45 kg; 1 cu ft = .03 cu m.

The volume of effluent actually may be greater than the volume of manure prior to digestion. This increase is due to the dilution water added to liquefy the manure to the desired solid content for the digester.

There is no increase in the amount of nitrogen, phosphorus or potassium in this material, although it may be in a more available form. A small portion of the nitrogen may be lost to the gas portion of the system, thus reducing the amount of nitrogen initially available.

Gas Production

Total bio-gas production varies depending on the organic material digested, the digester loading rate, and the environmental conditions in the digester. Under ideal conditions (95 degrees F temperature and proper pH), it is possible to produce about 45 cubic feet of gas at atmospheric pressure from one day's manure from a 1,000 pound cow. Not all of the bio-gas energy is available for use. Energy is required to heat and mix the digester, pump the effluent, and perhaps compress the gas. Table 2 summarizes the estimated gas production from various animal wastes.

Table 2: Bio-gas production (60% methane and 40% carbon dioxide) from animal wastes per 1,000 pounds body weight.

Animal	Volatile solids (lb per animal per day)	Probable volatile solids destruction (percent)[1]	Gas (cu ft per day)	Btu (per day)[2]
Beef	5.9	45	30	18,000
Dairy	8.6	48	44	26,000
Poultry, layers	9.4	60	72	43,000
Poultry, broilers	12.0	60	92	55,000
Swine (growing-finishing)	4.8	50	29	17,400

[1]Percent destruction of volatile solids varies depending primarily on detention time and digester temperature.

[2]Calculated at 600 Btu/ft^3* (heat content varies depending on quality of gas). For comparison, some other heating values are: gasoline, 124,000 Btu/gal; diesel fuel, 133,000 Btu/gal; natural gas, 850 to 1,000 Btu/ft^3; propane, 92,000 Btu/gal.

*To convert to metrics, use the following equivalents:
1 lb = .45 kg; 1 cu ft = .03 cu m; 1 gal = 3.8 1.

Basic Elements

Figure 1 shows the basic elements of a single-stage anaerobic digester. Submerged inflow and outflow lines are needed to prevent gas from escaping. Either a mechanical mixer can be used, or the liquid or gas can be recirculated for mixing.

A heat exchanger and thermostat maintain the proper temperature. The heat exchanger can be either internal or external.

Methane is drawn off the top of the digester. For gas utilization, a compressor and storage tank are used, along with the hardware to provide flame traps, regulators, pressure gauges, hydrogen sulfide scrubber, carbon dioxide removal and pressure relief valves. A common facility for gas storage is the floating cover that floats upward while maintaining essentially constant pressure.

Methane or bio-gas cannot be converted to a liquid under normal temperatures as can LP gas (LP gas liquefies at 160 psi). Under constant temperature, volume reduction is

inversely proportional to the pressure; that is, as the pressure doubles, the volume becomes half as large. The more the gas is compressed, the more energy it takes to compress it.

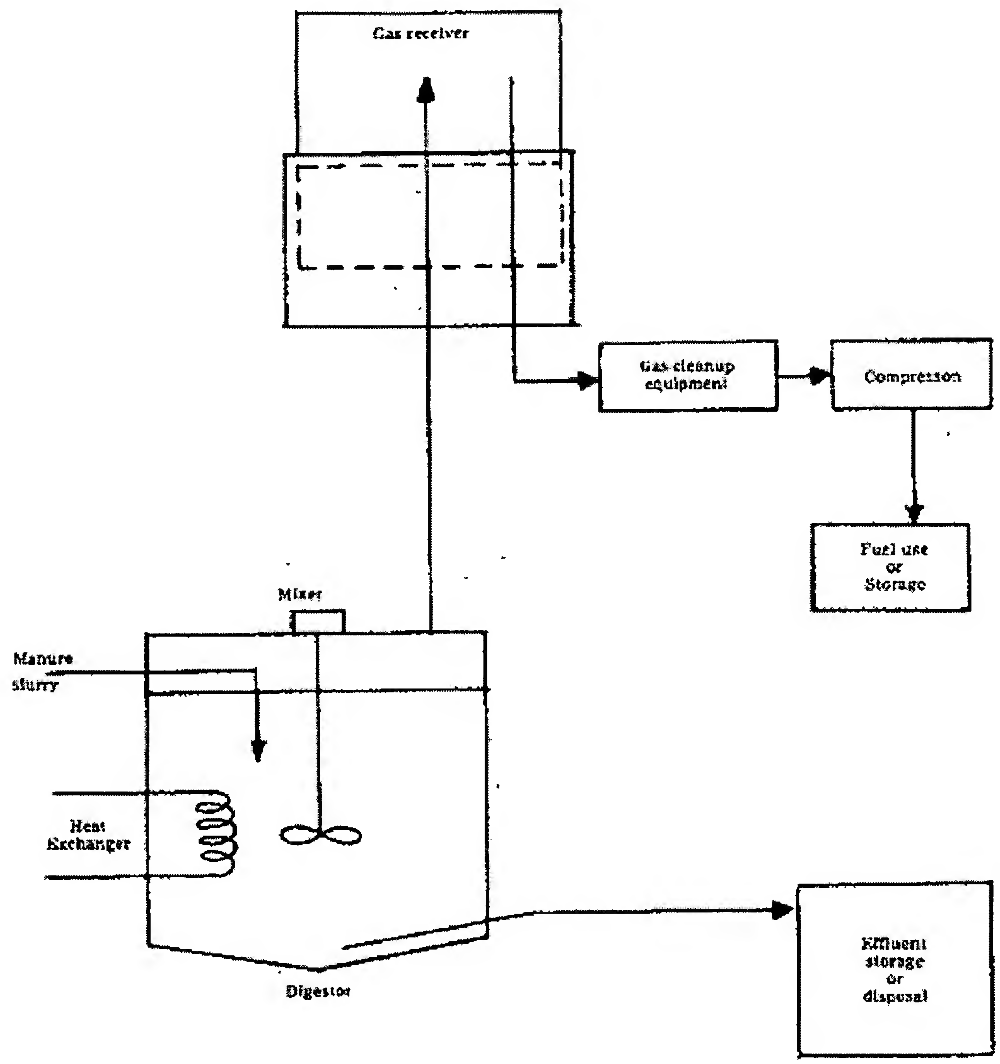

Figure 1: Basic components of anaerobic digester.

Liquefaction of methane requires pressures of nearly 5,000 psi and is not practical. If the gas is compressed to just 1,000 psi, it requires about 1,320 Btu of energy to put 6,350 Btu into a storage container.

Because bio-gas cannot be liquefied, it is best suited for stationary uses, such as cooking, heating water and buildings, air conditioning, grain drying, or operating stationary engines. It is not feasible as a tractor fuel. One cubic foot of compressed bio-gas at 3,000 psi would run a 100-horsepower tractor approximately 7 1/2 minutes. Most tractor fuel tanks occupy about 8 cubic feet. A special high-pressure tank with 8 cubic feet of gas and 3,000 psi would run the tractor approximately one hour. A 3,000-psi tank bouncing around on a tractor would present a serious safety hazard. The tractor would run 6 minutes on 8 cubic feet of gas compressed to 300 psi, a more realistic pressure.

A well-insulated, three-bedroom home takes about 900,000 Btu per day for heating during cold weather. Because 50 percent of the bio-gas goes back into maintaining the necessary temperature of the digester, it would take the manure from 50 cows to

produce enough bio-gas each day for home heating.

Bio-gas is produced on a relatively constant basis. Most applications are somewhat intermittent; therefore, storage is required. The amount of storage depends on the storage time and pressure. High demand applications, such as grain drying, normally are impractical due to the excessive storage capacity required.

Hazards

Methane in a concentration of 6 to 15 percent with air is an explosive mixture. Since it is lighter than air, it will collect in rooftops and other enclosed areas. It is relatively odorless and detection may be difficult. Extreme caution and special safety features are necessary in the digester design and storage tank, especially if the gas is compressed.

Summary

Concerns for energy conservation, environmental pollution, and the fact that agricultural organic wastes account for a major portion of our waste materials, has created renewed interest in the processing of these wastes for energy recovery.

Of the several types of energy capturing processes available, anaerobic digestion appears to be the most feasible for the majority of agricultural operations. Anaerobic digestion can stabilize most agricultural wastes while producing bio-gas or methane gas. This concept has been extensively applied in Europe and India during energy shortages. Similar equipment has been used for gas production with domestic wastes.

Primarily, disadvantages are the amount of management required due to the sensitivity of the digesters, the high initial investment required for equipment, and the fact that the wastes still must be disposed of after digestion.

Research is in progress to make the process more practical for energy production. Bacteriologists are investigating new strains of bacteria and culturing techniques for producing methane. Engineers are investigating digester designs and operation to reduce construction and operational requirements and costs.

[1] R.W. Hansen, former Colorado State University Cooperative Extension specialist and associate professor. 9/92. Reviewed 1/03 by L.R. Walker, Cooperative Extension specialist, chemical and bioresource engineering.

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Updated Tuesday, October 19, 2004.